

Years of Astronomy," &c., &c. He was elected a Fellow of this Society on the 12th of May, 1893.

The two Associates whose loss the Society has suffered during the last year were near the two ends of the illustrious list. Robert Luther was one of the oldest, and Keeler one of the youngest. Keeler might well have been elected earlier on his merits, but there was a difficult preliminary question of procedure to be settled—viz. whether a Fellow of the Society was eligible as an Associate. (For Keeler was one of several eminent American astronomers whom we are proud to have as actual Fellows, having joined the Society on the 14th of March 1890.) In 1898 the Council decided this question in the affirmative, and forthwith Barnard, Burnham, and Keeler were elected Associates on the 9th of December 1898. The first two were already also medallists of the Society; and there can be little doubt that only his premature and lamented death robbed Keeler of a similar honour, for his work was brilliant in quality, and he was an untiring worker. For the following particulars of his life the Council is chiefly indebted to the sympathetic and able notice by his successor in the directorate of the Lick Observatory, Professor W. W. Campbell (*Astrophysical Journal*, November 1900), to which reference should be made for a fuller account.

JAMES EDWARD KEELER was born in La Salle, Illinois, on the 10th of September 1857, of a long line of New England ancestry. The family removed to Mayport, Florida, in 1869, and here Keeler not only prepared himself by private study for the university, but began his astronomical work. He drew the planets at a 2-inch telescope, and constructed a transit circle, rough in appearance, but, no doubt, capable of giving good results in the hands of its skilful maker. The circle was of wood, with a paper graduated scale, and the clock was a "small kitchen affair, and kept execrable time. It had no second hand. . . . A tall pine tree nearly on the meridian served for purposes of collimation" (*Pub. Ast. Soc. Pacific*, xii. p. 169).

Keeler entered Johns Hopkins University, Baltimore, in 1877, and graduated in 1881; but some weeks before taking his degree he was appointed assistant to Langley at the Allegheny Observatory. Langley was just starting for the summit of Mount Whitney to make his determination of the value of the "Solar Constant," and Keeler accompanied him on the expedition. His work for the next two years was concerned with the results obtained. He then spent a year in Europe, attending lectures in Heidelberg and Berlin on physics and mathematics, returning to the Allegheny Observatory in the summer of 1884 to help Professor Langley with his researches on the infra-red portion of the spectrum.

Early in 1886 Keeler was appointed assistant to the Lick Trustees, and, reaching Mount Hamilton on the 25th of April, he established the time-service more than two years before the

Q

Observatory was completed and transferred to the University of California. On this completion in 1888 he was appointed astronomer in charge of the spectroscopic work, in addition to the time-service. In the three years which followed he produced some brilliant results, especially those relating to the motion of the nebulae in the line of sight. Taking advantage of the fact that, other things being equal, high dispersion does not weaken the brightness of a monochromatic line, Keeler used a grating for these faint objects, and the wave-lengths were measured in the third and fourth orders of spectrum. There was no available comparison line for the line measured (the principal nebular line at  $\lambda$  5007.05), but Keeler ingeniously deduced the wave-length of this line from observations on the *Orion* nebula, which he independently found (from the  $\beta$  line of hydrogen) to be receding from the solar system at about 18 km. per second. The velocities of thirteen planetary nebulae were thus found to vary from  $-65$  to  $+48$  km. per second, and are accordingly of the same order of magnitude as those of the stars.

In 1891 Keeler was summoned to succeed Langley at the Allegheny Observatory, and here he continued his spectroscopic successes. His main piece of work there, on the spectra of Secchi's third type stars, remains still unpublished; but everyone will remember his wonderful photograph of the spectra of *Saturn* and his rings, which first directly demonstrated the meteoric character of the ring, inferred theoretically by Clerk-Maxwell many years ago.

In 1898 Keeler was again called upon to return as Director to an observatory at which he had previously been an assistant—this time to the Lick Observatory. The tragedy of his early death is enhanced by the warm words of recognition of what he did in his few years of office, spoken by Professor Campbell in the name of the whole staff. "I but faintly reflect the views of every member of the staff," he writes, "and, indeed, of all who have been interested in the work of the Lick Observatory, when I say that his administration was completely successful. He cherished and promoted ideal conditions in this ideal place. He made a success of his own work in a splendidly scientific manner, and he saw to it that everyone had every possible opportunity to do the same. No member of the staff was asked to sacrifice his individuality in the slightest degree. Nor were demands made for immediate results. The peace of mind of the investigator, so absolutely required for complete success, was full and undisturbed."

The work he chose as his own on his return to Mount Hamilton was not spectroscopic as before, but the photography of nebulae with the Crossley reflector. It was one of the strongest traits in Keeler's character that he was ready to adapt himself at once to new conditions; and in the rather frequent changes of his all too short working life this capacity was of the greatest value to him. "He comprehended the possibilities and limitations of his situation," writes Professor Campbell, "and adapted himself to

them." Thus when he returned to Allegheny as Director, his spectroscopic researches were largely confined to the orange, yellow and green regions of the spectrum, since they would be less strongly affected by the smoky sky for which that vicinity is famous; and yet by attending to such limitations he managed to produce his beautiful photograph of the spectrum of *Saturn*. When he returned to the Lick Observatory he found the spectroscopic work in the able hands of Professor Campbell, and himself therefore undertook the solution of a troublesome question—or rather what had been a troublesome question before he came. The Crossley reflector, the 3-foot reflector with which Dr. Common showed the way in the photography of nebulae, afterwards acquired by Mr. Crossley of Halifax, had been presented by him to the Lick Observatory. The assistants told off to work with it failed to secure any good results, and blamed the instrument as antiquated and almost worthless. The new Director himself undertook to see what was wrong. He found a good deal capable of improvement and spent five months making one change after another. His account of this work (*Astrophysical Journal*, June 1900) is a model of clearness and completeness. At the end of this time the instrument immediately produced pictures of marvellous beauty in abundance. Keeler set himself to photograph the whole of Herschel's nebulae, and had done more than half at his death. The plates record incidentally a large number of new nebulae, and he estimated that the number to be discovered by the Crossley reflector could not be less than 120,000. The important fact that more than half the nebulae turn out to be spiral in form was established from these plates, and has an important bearing on the theory of the cosmogony.

His death was very sudden. He became weak in health in the summer of 1900, being unable to throw off a cold contracted in June, and left the observatory on the 30th of July, with no anxiety, to secure medical treatment and take a holiday. Increasing difficulty in breathing led him to seek skilled assistance in San Francisco on the 10th of August; the dangerous condition of his heart, which had been weak for some years, was realised on the next day; and on the 12th of August a stroke of apoplexy proved fatal.

He had the Rumford Medal of the American Academy in 1898, and the Henry Draper Medal in 1899. He was an editor of *Astronomy and Astrophysics*, and subsequently of the *Astrophysical Journal*, and a member of many learned Societies. He was, as above recorded, both a Fellow and an Associate of this Society. He married on the 16th of June, 1891, Miss Cora S. Matthews, at Oakley Plantation, Louisiana, and leaves two children.

H. H. T.

By the death of Dr. ROBERT LUTHER the Society loses one of its oldest Associates, and one who occupied a noteworthy position in the list. There are still three illustrious veterans who were elected

Q 2